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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/821,787	03/29/2001	Juergen Weichart	622/49809	8526

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CROWELL & MORING LLP
Intellectual Property Group
P.O. Box 14300
Washington, DC 20044-4300

EXAMINER

MCDONALD, RODNEY GLENN

ART UNIT	PAPER NUMBER
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1753

16

DATE MAILED: 04/02/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.
09/821,787

Applicant(s)
Weichart

Examiner
Rodney McDonald

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on Mar 17, 2003
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 2-5 and 13-36 is/are pending in the application.
- 4a) Of the above, claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 2-5 and 13-36 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☒ All b) ☐ Some* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
*See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s). _____ 6) ☐ Other: _____

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DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on March 17, 2003 has been entered.

Claim Rejections - 35 USC § 112

2. Claim 5 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim 5 is indefinite because it is unclear how the slots can be angled when claim¹³(1) requires a direct line of site from the chamber wall to the central axis.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was

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commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103© and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 2, 3, 5, 13, 14, 19, 21, 24-26, 30-32 and 34-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hull (U.S. Pat. 4,431,901) in view of Donohoe (U.S. Pat. 5,449,433).

Hull teach an induction plasma tube having a segmented, fluid-cooled internal radiation shield. (See Abstract)

FIGS. 1 through 8 illustrate four embodiments of the invention. The first embodiment, shown in FIGS. 1 and 2, generally includes a water-cooled copper induction coil 10 which surrounds a tubular quartz enclosure 12. The enclosure 12 extends upwardly from a water-cooled base 14 to an upper assembly 16 which includes a water supply manifold 18 and a water exhaust manifold 20. The supply and exhaust manifolds 18 and 20 include annular interior water channels 18a and 20a, which are connected to exterior supply and exhaust water fittings 18b and 20b, respectively. Likewise, the base 14 includes annular interior water cooling channels 14a and 14b which are connected to one another and which are connected to exterior water supply and exhaust fittings 14c and 14d, respectively. The base 14 and the manifolds 18 and 20 are all annular so as to define a central cylindrical cavity 22 wherein a plasma may be formed by application of a high

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frequency electrical current to the induction coil 10. A quartz window 24 is mounted on top of the upper assembly 16 for viewing the plasma formed in the central cavity 22. (Column 5 lines 43-63)

The plasma tube further includes a plasma gas intake tube 26 at the top of the upper assembly 16. The intake tube 26 is used to admit an ionizable gas such as argon into the cavity 22, and for maintaining a flow of such a gas downwardly through the tube. The intake tube 26 may also be used to introduce various gaseous reactants into the cavity 22. The plasma tube further includes a set of four process gas intake tubes 28 which open into the lower end of the cavity 22 from the base 14. These tubes 28 are used when it is desired to introduce gaseous reactants into the plasma arc downstream from the induction coil 10. (Column 5 lines 64-68; Column 6 lines 1-7)

The plasma tube of FIGS. 1 and 2 further includes a segmented shield 30 which consists of twelve substantially identical thick-walled copper tubes 32. The tubes 32 are affixed at their upper ends to the water exhaust manifold 20 and extend downwardly therefrom along the inside surface of the tubular quartz enclosure 12. The tubes 32 are parallel to one another and are equally spaced from one another so as to form a generally tubular, segmented shield which protects the quartz enclosure 12 from most of the heat and radiation emitted from a plasma located centrally in the cavity 22. The shield also reduces the amount of ionizing ultraviolet radiation emitted to the induction coil 10, thereby preventing electrical arcing between the windings of the coil 10. (Column 6 lines 8-22)

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The plasma tube is typically operated at a frequency of 400 kHz to 5 MHz, at a power level of approximately 20 kW applied to the induction coil. (Column 6 lines 45-48)

FIG. 8 shows a fourth embodiment that is essentially the same as the embodiment of FIGS. 5-7, except that it lacks the boron nitride rods 56. The embodiment of FIG. 8 includes a shield 58 consisting of simple wedge-shaped segments 60, each having a bore 60a and water supply tube 62. This embodiment has been demonstrated to attain a sustainable temperature of approximately 15,000.degree. C. with an argon plasma at atmospheric pressure and a 400 kHz power supply. Even without the boron nitride shielding rods of the third embodiment, the shield of the fourth embodiment is sufficiently effective to permit the quartz enclosure to be touched manually immediately after the power is turned off. Also, it has been found that ordinary glass may be used to form the enclosure, rather than quartz, and yet permit attainment of plasma temperatures up to 15,000.degree. C. It is believed that the efficiency of this design is at least partially due to the narrow, relatively long gaps between the adjacent shield segments 60, which significantly limit the amount of radiation that can be transmitted from the plasma through the shield, but which do not significantly impair the electrical coupling between the coil and the plasma. (Column 8 lines 44-66)

Referring to FIG. 4, the plasma shield 38 of the second embodiment consists essentially of twelve shield segments 40 which are chevron-shaped in cross-section. Each segment 40 includes a central bore 40a and a water supply tube 42 located therein. Each segment 40 of the shield is thus cooled by means of the counterflow cooling system described above. The chevron

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cross-sectional shape of the segments 40 results in a partially interlocking arrangement between adjacent segments, wherein the gaps between the segments 40 are *angled*. This results in shielding of the quartz enclosure 12 and the coil 10 from direct radiation from the plasma in the cavity 22.

(Column 7 lines 36-41)

The differences between Hull and the present claims is that the treatment of workpieces is not discussed and the distribution of the slits in the Faraday shield is not discussed.

Donohoe teach an apparatus for etching substrates utilizing an electrostatic shield. (See Abstract)

Donohoe teach in Fig. 3 a reactor of the present invention having the electrostatic shield in place. Fig.3 is the same as Fig. 2 with the exception of the electrostatic shield 17. The reactor has two loop antennas 11. The bell jar 10A is typically comprised of alumina or quartz or a similar dielectric which is removed relatively easily by the ion bombardment. The electrostatic shield 17 significantly decreases the capacitive coupling between the antenna 11 in the Mori source reactor (or the coils in another type of inductively coupled source) and the plasma. The capacitive coupling is decreased because the shield 17 protects or blocks the plasma from the antenna's electric field. The electric field is responsible for the capacitive coupling. (Column 3 lines 8-17; Column 4 lines 11-18; Figs. 2 and 3)

The shield in the preferred embodiment is cylindrical in shape and fits over the bell jar 10A portion of the reactor 10. However, it is possible to use a shield 17 having a hemispherical shape (not shown), or alternatively, having a combination cylindrical/hemispherical shape (not shown).

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The shield 17 is disposed between the bell jar 10A and the antennae 11, where it functions to substantially prevent capacitive coupling between the antennae 11 and the plasma. (Column 4 lines 40-48)

Bands or strips of metal 17C are located between the slits 17A. The bands 17C have a width which is preferably larger than the width of the intervening slits 17A. The width of the bands or strips 17C will vary, depending upon the reactor parameters chosen. However, generally the width in the relative range of 1 cm is used for the metal bands 17C. The width of the intervening slits 17A tends to be a little smaller, and is generally in the range of 0.2 cm to 0.5 cm. (Column 4 lines 49-57)

The electrostatic shield 17 is comprised of a conductive material, preferably copper. Copper is preferred due to its cost and availability, and the ease with which it can be cut. (Column 4 lines 58-61)

The motivation utilizing a distribution of slits in an electrostatic shield during vacuum treatment is that it allows for prevention of capacitive coupling. (Column 2 lines 1-13)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have modified Hull by utilizing a distribution of slits as taught by Donohoe because it allows for preventing capacitive coupling.

5. Claims 4, 15, 20, 22, 23, 27, 28 and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hull in view of Donohoe as applied to claims 2, 3, 5, 13, 14, 19, 21, 24-26, 30-32 and 34-36 above, and further in view of Lai et al. (EP 0 801 413).

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The differences not yet discussed is biasing the screen to a reference potential, utilizing two electrodes connected to a power source, utilizing a sputtering target and exchanging the screen body.

Lai et al. teach in Figure 5 an elevational cross section of an ICP reactor according to a presently preferred embodiment of the present invention. Besides implementing the double vertically slotted shield as discussed above, there are also several other innovative features in this design. An upper and lower adapter end flange are used to provide vacuum seals between the dielectric cylinder 24 and other portions of the reactor chamber. It is presently preferred to fabricate the adapters of aluminum. In Fig. 5 lower aluminum adapter flange 34 is shown sealing dielectric cylinder 24 to reactor chamber flange 36. Similarly the *magnetron target* assembly 38 forms a cover of the reactor chamber and includes magnetron target 40 and a ceramic insulator 42 to which upper aluminum adapter flange 32 seals dielectric cylinder 24. (Column 8 lines 12-27)

Aluminum adapter flanges 32, 34 also serve as electrical conductors to ground the shields 28, 30 to the chamber wall and may be used to aid in supporting the weight of the upper portion of the chamber assembly including the magnetron target assembly 38, if desired. The spacing between the two aluminum adapter flanges 32, 34 is determined by: (1) the outer *ground* shield 44 (*which serves as the return RF current path of the shields 28, 30* and as a radiation shield for the RF coils 26 for purposes of reducing RF interference emitted to the environment); (2) by insulating standoffs between them; or (3) by the height of the dielectric cylinder 24. (Column 8 lines 28-39)

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The Faraday-sputter shield structure 28, 30 essentially eliminate capacitive coupling between the RF coil and the plasma by providing an electrical short that prevents the capacitive component of the field caused by the RF coil from propagating to the inside of the Faraday-sputter shield. (Column 8 lines 54-59)

In order to form a plasma a radio frequency power source is generally used to provide power *to one or more powered electrodes* within a vacuum vessel containing a gas at a predetermined pressure in which the processing is to take place. (Column 1 lines 16-24)

Figure 1 shows biasing the substrate support with RF or DC power supply. (See Figure 1)

Figs. 2A-2E show shield configurations. (See Figs. 2A-2E)

Lai et al. teach replacing the shield after a certain time. (Column 9 lines 17-19)

The motivation for utilizing an electrostatic shield in a sputter apparatus is that it allows for blocking capacitive coupling between the RF antenna and the plasma inside the vacuum envelope. (Column 5 lines 11-13)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have biased the screen to a reference potential, utilized two electrodes connected to a power source, utilized a sputtering target and exchanged the screen body as taught by Lai et al. because it allows for capacitive coupling between the RF antenna and the plasma inside the vacuum envelope.

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6. Claims 16-18 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lai et al. in view of Donohoe as applied to claims 2, 3, 5, 13, 14, 19, 21, 24-26, 30-32 and 34-36 above, and further in view of Nihei et al. (U.S. Pat. 4,999,096).

The differences not yet discussed is the controlling circuitry.

Nihei et al. teach in FIGS. 1 to 3, an embodiment of a thin film forming apparatus according to the present invention will be described. FIG. 3 diagrammatically shows waveforms used in the apparatus. In FIG. 3, PW denotes a sputter peak power (voltage), BW a sputter base power (voltage), PV a bias peak voltage, BV a bias base voltage, BW/PW a sputter base power ratio, $T2/(T1+T2)$ a bias ratio, and $(T1+T2)$ a switching period. Referring to FIG. 1, the thin film forming apparatus comprises a waveform-controlled sputter power source 2, a constant-voltage waveform-controlled reverse sputter power source 1, a bias current detecting sensor 4, a high frequency coil 5 for generating plasma, a bias current controlling high frequency power source 3 for controlling a bias current and enabling a stable discharge at a high vacuum region, a vacuum chamber 17 within which film is formed, a substrate (e.g., Si substrate) 8, a target 6, insulators 10, and an optional waveform generator 9 made of a CPU and the like for setting sputter power, bias voltage and current waveforms under program control. (Column 4 lines 55-68; Column 5 lines 1-9)

With the thin film forming apparatus constructed as above, first the optional waveform generator 9 sets the sputter power waveform, bias (reverse sputter) waveform and bias current. These signals set by the optional waveform generator 9 are supplied to the waveform controlled

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sputter power source 2, constant-voltage waveform controlled reverse sputter power source 1 and bias current controlling high frequency power source 3. These power sources have feedback functions to maintain the waveforms as set, even under variation of loads or the like. Therefore, a change in any one set value will not affect the other values. A bias current control method which is one of the features of this invention will be described in detail. A bias current with the bias voltage PV set, e.g., at 150 V changes if for example a sputter power is changed. To avoid this, a bias current is detected by the bias current detecting sensor 4 and compared with a signal set by the optional waveform generator 9. Based on this comparison, the bias current is maintained at the set value by controlling a high frequency power supplied to the high frequency coil 5 by means of the bias current controlling high frequency power source 3. These operations serve to maintain stable discharge at a high vacuum region. (Column 5 lines 10-33)

Sine Nihei et al. teach control means for sensing the current which is made up of power and voltage it is believed to meet the voltage sensing limitation. (See Nihei et al. discussed above)

The motivation for utilizing control circuitry is that it allows for maintaining stable discharge. (Column 5 lines 32-33)

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have utilized controlling circuitry as taught by Nihei et al. because it allows for maintaining stable discharge.

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Response to Arguments

It is believed that Hull teach a line of sight between the chamber wall and the chamber axis through the shield see particularly Figure 8. (See Hull discussed above)

This action is made NON-Final based upon the new rejections.

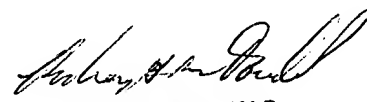
7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Rodney McDonald whose telephone number is 703-308-3807. The examiner can normally be reached on M-Th from 8 to 5:30. The examiner can also be reached on alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam X. Nguyen, can be reached on (703) 308-3324. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9310.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

March 31, 20003

RM


RODNEY G. MCDONALD
PRIMARY EXAMINER